UNIVERSITI TEKNOLOGI MARA

VOLTAGE AND LOAD PROFILES ESTIMATION OF DISTRIBUTION NETWORK USING INDEPENDENT COMPONENT ANALYSIS

MASHITAH BINTI MOHD HUSSAIN

Thesis submitted in fulfilment
of requirement for the degree of
Master of Science

Faculty of Electrical Engineering

September 2014

AUTHOR'S DECLARATION

I declare that the work in this thesis/thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Mashitah Binti Mohd Hussain
Student I.D. No.	:	2010234344
Programme	:	Master of Electrical Engineering- (EE780)
Faculty	:	Electrical Engineering
Thesis Title	:	Voltage And Nodal Load Profiles Estimation Of Distribution Network Using Independent Component Analysis
Signature of Student	:	.....
Date	:	September 2014

ABSTRACT

This thesis presents research on voltage and load profiles estimation using independent component analysis technique. The uniqueness of this technique is limited information parameters on distribution system required. Usually voltage and load profiles are used as reference to electricity provider when supplying electricity to consumer on proper tariff. Thus, it is important to capture profiles accurately in order to avoid energy wastage and high cost for equipment installation. The work presented in this thesis is using statistical technique to predict voltage profile at source distribution system and load profiles on distribution system. Initially, the research focuses on three main tasks. First, voltage profile on source distribution system is estimated. The voltage profile is predicted using Independent Component Analysis (ICA) algorithm. The voltage profiles are estimated for 24- hours with time interval of 1 minute. Theoretically, when voltage source is controlled, the losses occur on the system is reduced. The task and analysis presented will help system loss their power while transmitting power from transmission to distribution system. Secondly, load profile in a multiple power flow solutions for every minute in 24 hours per day is estimated. A method to calculate multiple solutions of non linear profile is introduced. The Power System Simulation/Engineering (PSS@E) and python has been used to solve the load power flow. The result of this power flow solutions has been used to estimate the load profiles for each load buses using Independent Component Analysis (ICA) without any knowledge of parameter and network topology of the systems. The proposed algorithm is tested with IEEE 69 test bus system which represents the distribution part and the method of ICA has been programmed in MATLAB R2012b version. Next, an electrical load profiles is estimated using limited information to ensure proper power usage measurement of the customers. ICA technique is able to separate the mixed signal into their source signals. Using this method, the load profiles on feeder distribution can be estimated without any knowledge of the network topology and electrical parameters. In addition, a real-time load profiles on feeder distribution can be established instead of load modelling technique by using incoming distribution feeder data profiles. The ability of ICA algorithm to separate the profiles was evaluated. The work is focused on analysing the results of simulation using ICA method including voltage source control and electric losses of the system. Simulation results were obtained in Chapter 4.This thesis compares the result between original and estimated load profiles. Meanwhile, the result of voltage profile is tested on distribution system to investigate losses behaviour. The losses of simulation results with different tap changer and voltage set presented in first task are compared and discussed in this thesis. The estimation quality is verified by using error measures of the load profiles. All simulation results and errors of estimations are discussed in this thesis.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

Energy load profile is an estimate of the total energy demand from a power system or sub-system over a specific period of time. The load profiles are used to ensure customers are billed accurately as well as to identify the type of customer class in power system. Utilities have the responsibility to put a consumer on a proper tariff. However, to obtain customers accurate consumption will increase cost such as placing a smart meter to capture an accurate reading. Therefore, a cost effective solution is required as an alternative way.

Load profile is a graph which varies according to the consumer type versus time. The typical types of consumer are residential, commercial, industrial and others (example: street lighting). Most consumption are measured based on the meter reading on monthly basis schedules. To be one load profile, the data consumptions is captured for every 15 minutes or one minute in 24 hours. Moreover, this load profiles are used to determine the customer usage where each hour aggregates representing the amount of energy uses in total energy demand and also for customer billing. The data is captured using direct meter reading but some network areas such as distribution network transformers do not have a meter to capture the data consumption. The task can be accomplished using smart grid meters, data logging sub meters and portable data loggers. The detail analysis is referred to the load demand profiles. Profiling allows electricity services provider to determine the tariff more precisely. Each customer daily load profiles may differ depends on the type of customer [1]. Therefore, it is essential to estimate load profiles accurately to achieve high efficiency and reliability of the power transmission.

Some measurements such as voltage magnitudes, voltage angles and bus power injections are required in order to analyse the electrical power systems. If the values of a particular system state known, the power flow and load bus can be found. State estimation is a method which utilizes the system state to evaluate from real-time measurements [2]. The load profiles which were estimated from network topology and